Instability, patterns and localized structures in photonic crystal thin films

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We consider a system in which a nonlinear photonic crystal film is irradiated from the top by a laser beam [1]. Under some conditions this system can be considered as two subsets of interacting nonlinear planar resonators. In this case the system can be described by the system of equations:

$$\partial_t U_{n,m} = -f(|U_{n,m}|)U_{n,m} + is_1(V_{n,m} - U_{n,m}) + is_2(V_{n-1,m+1} - U_{n,m}) + ir_1(V_{n,m+1} - U_{n,m}) + ir_2(V_{n-1,m} - U_{n,m}) + U_p$$

$$\partial_t V_{n,m} = -f(|V_{n,m}|)V_{n,m} + is_1(U_{n,m} - V_{n,m}) + is_2(U_{n+1,m-1} - V_{n,m}) + ir_1(U_{n,m-1} - V_{n,m}) + ir_2(U_{n+1,m} - V_{n,m}) + U_p,$$

where indices n,m mark resonators, $U_{n,m}$ and $V_{n,m}$ are the amplitudes of the fields in the resonators, f describes the nonlinearity which depends on the intensity, $s_{1,2}$ and $r_{1,2}$ account for the coupling between the resonators, and $U_p = U\exp(idt)$ is the pump field, where d is the pump frequency detuning.

We show analytically that this system exhibits modulation instability that can be stabilized for some ranges of detuning provided the dispersion characteristic has a sufficiently wide band gap. For the cases of Kerr and dissipative nonlinearities, it is shown by numerical simulation that the instability can lead to the formation of various patterns. Localized structures of light are also found.

[1] J.M. Pottage, E. Silvestre and P.St.J. Russell, *J. Opt. Soc. Am. A*, **18** 442 (2001)